PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-244740
(43)Date of publication of application : 30.08.2002

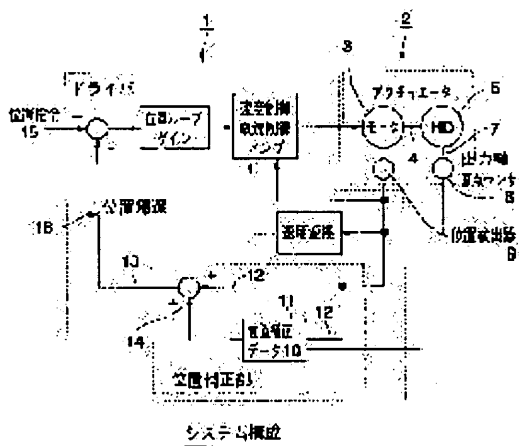
(51)Int.Cl. G05D 3/12
F16H 1/32

(21)Application number : 2001-041788
(22)Date of filing : 19.02.2001

(71)Applicant : HARMONIC DRIVE SYST IND CO LTD
(72)Inventor : KANAYAMA NAOKI
SASAKI KOZO

(54) POSITIONING ERROR COMPENSATION METHOD FOR ACTUATOR

(57)Abstract:
PROBLEM TO BE SOLVED: To improve positioning precision in an actuator provided with a wave gear reduction gear.
SOLUTION: A drive controller 1 of the actuator stores and holds error compensation data 10 indicating an error compensation value for each rotation angle position of a motor rotary shaft in its error compensation data storage part 11. This data 10 is obtained by obtaining positioning error of the actuator 2 by measuring one rotation of an output shaft 7 based on an absolute position of the output shaft 7 of the wave gear reduction gear 5 and averaging the measured error data.. When drive control is performed, a rotation position of the motor rotary shaft 4 is detected, an error compensation value allocated for the rotation position in the error compensation data 10 is added to the detected rotation position information 12 to prepare rotation position compensation information 13 and use this information as position feedback information for positioning-controlling the actuator output shaft 7.



CLAIMS

[Claim(s)]
[Claim 1] Are the locational error amendment approach in the actuator equipped with the wave-motion gear reducer which slows down a motor and motor output rotation and is transmitted to a load side, and the locational error corresponding to a location of an actuator output shaft is measured absolutely. Create the error correction data to the rotation location of said motor revolving shaft, and the rotation location of said motor revolving shaft is detected. The error correction value currently assigned to the detected rotation positional information in said error correction data is added to the rotation positional information concerned. The locational error amendment approach of the actuator characterized by creating rotation location amendment information and using the created rotation location amendment information as position feedback information for carrying out point to point control of said output shaft.
[Claim 2] The locational error amendment approach of the actuator which will be characterized by for said output shaft measuring said locational error by at least 1-/(R+1) rotation, and creating said error correction data in claim 1 if R is made into the ** ratio of a wave-motion gear reducer.
[Claim 3] The locational error amendment approach of the actuator characterized by averaging the error data which said output shaft measured said locational error a part made one revolution at least, and measured it in claim 2, and creating the error correction data showing the error correction value over each rotation location of said motor revolving shaft.
[Claim 4] The error correction data storage section with which are the drive control device of the actuator which amends a locational error by the approach according to claim 1, and said error correction data are remembered to be, The output-shaft zero sensor for [of said output shaft] detecting a location absolutely, and the position transducer which detects the rotation location of said motor revolving shaft, The rotation positional information supplied from said output-shaft zero sensor and said position transducer, and the rotation location amendment information creation section which creates said rotation location amendment information based on said error correction data, The drive control unit of the actuator characterized by having the feedback control section which carries out feedback control of said actuator by making said created rotation location amendment information into position feedback information so that it may become the target position shown using location command information.
[Claim 5] It is the drive control unit of the actuator which storage maintenance of said error correction data is carried out in claim 4 at said position transducer, and is characterized by downloading from this position transducer after powering on at said error correction data storage section.
[Claim 6] It is the drive control unit of the actuator characterized by being the data stream of the amendment pulse as error correction information in each rotation location of said motor revolving shaft while said output shaft carries out 1-/(R+1) rotation of said error correction data in claims 4 or 5, or the multiplier train of the approximate expression showing the error correction information concerned.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the drive control unit of the actuator which performs positioning actuation by the locational error amendment approach and the amendment approach concerned of the actuator equipped with the wave-motion gear reducer.
[0002]
[Description of the Prior Art] The thing of a configuration of slowing down motor output rotation with a wave-motion gear reducer, and moving the member by the side of a load to a target position as an actuator, is known. The wave-motion gear reducer is equipped with the annular rigid internal gear, the annular flexible external-tooth gearing, and the wave-motion generator.
[0003] With a typical configuration, a flexible external-tooth gearing is ****(ed) by the ellipse form by the wave-motion generator. If the external-tooth part located in the both ends of the direction of an ellipse form major axis is clenched by the internal-tooth part to which a rigid internal gear corresponds and this wave-motion generator is rotated by the motor Both gearings' engagement position moves to a circumferencial direction, and the relative rotation according to both gearings' number-of-teeth difference (2n sheet, n= 1, 2, 3 ...) occurs on both the gearings concerned. Generally, the number of both gearings' number-of-teeth differences is two, and a rigid internal gear is fixed, a flexible external-tooth gearing rotates as a moderation rotation output element, and the rotation drive of the member by the side of the load connected with the flexible external-tooth gearing concerned is carried out at a low speed. The reduction gear ratio i in this case is i= 1/R = (Zf-Zc)/Zf. Here, R is a ** ratio, Zf is a flexible external-tooth gearing's number of teeth, and Zc is the number of teeth of a rigid internal gear. For example, in the case of Zf=100 and Zc=102, a reduction gear ratio i is 1/50, and output rotation becomes the reverse sense to a motor rotation direction.
[0004] Generally the drive control device of the actuator of this configuration is performing point-to-point control of an actuator by feedback control.
[0005]
[The technical problem which invention will solve and to carry out] However, there is an angular transmission error in a wave-motion gear reducer, and an error occurs according to this error between the actual positioning location by the actuator output shaft (output shaft of a wave-motion gear reducer), and a target positioning location. If this error can be compensated, the positioning accuracy of the actuator equipped with the wave-motion gear reducer can be improved.
[0006] if a locational error component when both gearings' number-of-teeth difference uses the wave-motion gear reducer of two sheets sets the ** ratio of the wave-motion gear reducer concerned to R here -- the error component (3) of the error component (2) period (R+1) of the (1) period R per output-shaft 1 rotation -- it can divide into the other error component. The error component of a period R originates in a rigid internal gear, and the error component of a period (R+1) originates in a flexible external-tooth gearing.
[0007] The technical problem of this invention is in the drive control device of the actuator equipped

with the wave-motion gear reducer by adding the location amendment function for amending the above-mentioned locational error of the period (R+1) of (2) which originates in the feedback control loop of the position control at the angular transmission error of a wave-motion gear reducer to improve the positioning accuracy of the drive control device concerned.
[0008]
[Means for Solving the Problem] In the actuator equipped with the wave-motion gear reducer which the locational error amendment approach of this invention slows down :motor and motor output rotation, and is transmitted to a load side in order to solve the above-mentioned technical problem The locational error corresponding to a location of an actuator output shaft is measured absolutely. The error correction value which creates the error correction data to the rotation location of said motor revolving shaft, detects the rotation location of the; aforementioned motor revolving shaft, and is assigned to the detected rotation positional information in the; aforementioned error correction data is added to the rotation positional information concerned. It is characterized by using the rotation location amendment information of which created rotation location amendment information and; creation was done as position feedback information for carrying out point to point control of said output shaft.
[0009] What is necessary is here, for said output shaft to measure said locational error by at least 1-/ (R+1) rotation, and just to create said error correction data.
[0010] What is necessary is generally, for said output shaft to measure said locational error a part made one revolution at least, and to average the measured error data and just to create the error correction data showing the error correction value over each rotation location of said motor revolving shaft.
[0011] Next, this invention By the above-mentioned approach A locational error the drive control device of the actuator to amend -- it is -- : -- the error correction data storage section said error correction data are remembered to be, and; -- the output-shaft zero sensor for [of said output shaft] detecting a location absolutely, and; -- the position transducer and; which detect the rotation location of said motor revolving shaft -- said -- an output-shaft zero sensor And the rotation positional information supplied from said position transducer and the rotation location amendment information creation section which creates said rotation location amendment information based on said error correction data; Said created rotation location amendment information is made into position feedback information. It is characterized by having the feedback control section which carries out feedback control of said actuator so that it may become the target position shown using location command information.
[0012] What is necessary is here, to be able to carry out storage maintenance of said error correction data at said position transducer, and just to download from this position transducer after powering on in this case at said error correction data storage section.
[0013] Moreover, said error correction data can be made into the data stream of an amendment pulse, or the multiplier train of the approximate expression showing the error correction information concerned.
[0014]
[Embodiment of the Invention] An example of the drive control unit of the actuator which applied this invention to below with reference to the drawing is explained.
[0015] Drawing 1 is the outline block diagram showing the drive control unit of the actuator of this example. this -- a drive -- a control device -- one -- driving -- having -- a book -- an example -- an actuator -- two -- a motor -- three -- this -- a motor -- a revolving shaft -- four -- connecting -- having had -- the wave motion -- a gear reducer -- (-- HD --) -- five -- a motor -- a revolving shaft -- four -- absolute rotation -- a location -- detection -- being possible -- a position transducer -- six -- the wave motion -- a gear reducer -- five -- an output shaft -- namely, -- an actuator -- an output shaft -- seven -- absolutely -- a location -- detecting -- a sake -- a zero -- a sensor -- eight -- having -- **** . Position transducers 6 are position transducers which can detect a location absolutely, such as a rotary encoder and a potentiometer.
[0016] It has an internal gear, a rigid flexible external-tooth gearing, and a rigid wave-motion generator, and a wave-motion generator is used as a motor rotation input element, and an internal gear is fixed and let wave-motion gearing 5 be the output element (output shaft 7) of moderation rotation of a flexible external-tooth gearing. The wave-motion generator has an ellipse form, the number of both gearings'

number-of-teeth differences is two, and a flexible external-tooth gearing is stir-fried by the ellipse form, and meshes partially at the both ends of the direction of a major axis of an ellipse form to a rigid internal gear, and two engagement positions move him to a circumferencial direction with rotation of a wave-motion generator. Since the reduction gear ratio i of wave-motion gearing 5 is i= 1/R = (Zf-Zc)/Zf, number-of-teeth Zf=100 of a flexible external-tooth gearing, and in the case of number-of-teeth Zc=102 of a rigid internal gear, a reduction gear ratio i is 1/50, and output rotation becomes the reverse sense to a motor rotation direction.
[0017] The drive control unit 1 which controls the drive of an actuator 2 The error correction data storage section 11 the error correction data 10 for compensating the locational error resulting from the angular transmission error of the wave-motion gear reducer 5 are remembered to be, The rotation positional information 12 supplied from a position transducer 6, and the rotation location amendment information creation section 14 which creates the rotation location amendment information 13 based on the error correction data 10, It has the feedback control section 16 which carries out feedback control of the actuator 2 by making created rotation location amendment information 13 into position feedback information so that it may become the target position shown using the location command information 15. The above-mentioned rotation location amendment information creation section 14 can be used as an adder or a subtractor.
[0018] (Error correction data) Here, the error correction data 10 of this example are created as follows. First, the locational error of the motor revolving shaft 4 in an actuator 2 is compressed into 1 for a reduction gear ratio of the reducer concerned by moderation of the wave-motion gear reducer 5 with which this is connected. Since the ** ratio of the wave-motion gear reducer 5 is 50 in this example, the locational error of the motor itself is compressed into 1/50. Therefore, since the locational error of an actuator 2 originates mainly in the angular transmission error of the wave-motion gear reducer 5, the unidirectional-approach precision of the actuator 2 concerned will be decided by the angular transmission error of the wave-motion gear reducer 5.
[0019] Unidirectional-approach precision positions one after another in the hand of cut of the fixed direction, and is each location, the difference of the include angle actually rotated from the criteria location and the include angle which should be rotated is searched for, and the maximum under 1 rotation of these values is expressed.
[0020] In this example, the locational error of the unidirectional-approach precision of an actuator 2, i.e., an actuator, is measured a part of the actuator output shaft 7 made one revolution based on the absolute location of an output shaft 7. Since it is reduction gear ratio i=1/50 of the wave-motion gear reducer 5 in this example, when the motor revolving shaft 4 rotates 50 times, an output shaft 7 (flexible external-tooth gearing) will make one revolution. In this measurement, the output of the zero sensor 8 is absolutely used at the time of the initial actuation for location detection.
[0021] In addition, instead of unidirectional-approach precision, even if the include-angle intermediary precision of a wave-motion gear reducer is used for the data to measure, they are substantially the same. Moreover, although a part for 1-/(R+1) rotation of an output shaft 7 is sufficient as measurement, it may continue more than one revolution and, of course, you may measure.
[0022] Next, the measured data are equalized and the error correction data 10 corresponding to the rotation location of the motor revolving shaft 4 are created. Below is enough for the magnitude of this error correction data 10 by one rotation of the motor revolving shaft 4.
[0023] The format of the created error correction data 10 can be made into the amendment pulse number for error correction to each angle-of-rotation location of the motor revolving shaft 4. Instead the fourier expansion into series of the error correction data of each rotation location of the motor revolving shaft 4 is carried out, and it asks for an approximation curve, and may be made to carry out storage maintenance by using each multiplier of the Fourier series showing the approximation curve concerned as the error correction data 10. In this case, what is necessary is to compute amendment data by applying the multiplier which is carrying out storage maintenance to an approximate expression, and just to create the data stream of an amendment pulse in the initialization processing after turning on the drive power source of the drive control unit 1.

[0024] Here, in this example, since this error correction data 10 should just create the thing of the die length equivalent to 1/(R+1) of an output shaft 7, since it is the ** ratio R= 50, if it converts into an input shaft (motor revolving shaft), a motor revolving shaft needs to create the data for 360 degreex50 / 51= 352.9-degree rotation. This error correction data 10 is every 3-degree rotation of a motor revolving shaft and 352. It can set up every 120 9-degree division. However, it is 352 in this case. What is necessary is to establish an origin/datum in an output shaft 7 and just to create amendment data on the basis of there, since the include angle of 9 degrees cannot be accepted. It is a motor revolving shaft and is 359. ********** (R+1) and amendment for one rotation of an output shaft 7 will be made in 2-degree amendment.
[0025] (Locational error amendment actuation) Next, amendment of the locational error which is the description part of the drive control action of the actuator 2 by the drive control device 1 is explained. It asks for the amendment pulse number of the motor revolving shaft 4 expressed by the feedback pulse concerned which corresponds from the error correction data 10 absolutely based on a location, the amendment pulse number is added to a feedback pulse (12) in the rotation location amendment information creation section 14, and it returns to the feedback pulse (12) of the location detection from a position transducer 6 by making an addition result into a location feedback pulse (13) at the feedback-control section 16. In the feedback control section 16, based on the location feedback pulse (13) concerned, feedback control of the actuator 2 is carried out so that it may become the target position directed using the location command information 15 that it is inputted.
[0026] In addition, in this example, it is made to carry out storage maintenance of the error correction data 10 at the drive control unit 1. Instead, storage maintenance of the error correction data 10 may be carried out at the position transducer 6 of an actuator 2. In this case, what is necessary is just to constitute in initialization processing immediately after supplying a power source to the drive control device 1, so that the error correction data 10 currently held at the position transducer 6 of an actuator may be downloaded to the drive control-device 1 side.
[0027] (Gestalt of other operations) Although the above-mentioned example performs control which removes the error of the period (R+1) contained in an actuator, if the error component of a period R is also removed collectively, of course, it can perform locational error amendment with a very high precision.
[0028] First, the error component of a period R is removable as follows. That is, the locational error of such an output shaft can be amended based on the absolute location of one revolution of a motor revolving shaft. Specifically the locational error of an actuator 2 by [of one revolution of the motor revolving shaft 4] measuring based on a location absolutely As opposed to the rotation positional information which creates error correction data, detected the rotation location of the motor revolving shaft 4, and was detected What is necessary is to add the error correction value currently assigned to the rotation location concerned in error correction data, to create rotation location amendment information and just to use the created rotation location amendment information as position feedback information for carrying out point to point control of the output shaft.
[0029] In this case, when [of the motor revolving shaft's 4 one revolution of the locational error of an actuator 2] an output shaft measures by one revolution at least based on a location absolutely, error correction data can be created. Moreover, the error data of the motor revolving shaft's 4 one revolution of the locational error of an actuator 2 which the output shaft 7 measured a part made one revolution at least based on the location absolutely, and were measured can be averaged, and the error correction data showing the error correction value over each rotation location for one motor revolving-shaft revolution can be created.
[0030] Next, in order to remove the error component of a period (R+1), and the error component of a period R, to prepare two kinds of amendment tables for amending these errors for the location amendment data storage section in <u>drawing 1</u> as location amendment data, and based on the absolute location of an input shaft 4, to draw correction value from two tables and what is necessary is made just to amend to coincidence.
[0031] Here, the error correction data of a period (R+1) can be created based on the data after error

assistant Masashige part removal of a period R (data obtained by observation data or simulation). Of course, since the error component of a period (R+1) is also calculable from a measurement result, the error component of an output shaft 7 may be measured and the error correction table of a period (R+1) may be directly created from there.
[0032] In addition, amendment actuation of the creation approach of the error correction data of a period R and the error component of a period R using the error correction data concerned is explained below.
[0033] First, the locational error of the unidirectional-approach precision 2 of an actuator 2, i.e., an actuator, is measured a part of the actuator output shaft 7 made one revolution based on the absolute location of the motor revolving shaft 4. For example, when the ** ratio of the wave-motion gear reducer 5 is 1/50 and the motor revolving shaft 4 rotates 50 times, an output shaft 7 will make one revolution.
[0034] Based on the output of a position transducer 6, this locational error is measured, whenever 3 degrees of motor revolving shafts 5 rotate. In this case, a measure point is 120 points (360 degrees / 3 degrees) about the motor revolving shaft 5, and becomes a part for 120 point x (** ratio) in the actuator output shaft 7.
[0035] In addition, instead of unidirectional-approach precision, even if the include-angle intermediary precision of a wave-motion gear reducer is used for the data to measure, they are substantially the same. Moreover, as for measurement, it is needless to say that it may continue not only a part of an output shaft 7 made one revolution but more than one revolution, and you may measure.
[0036] Next, the error data of each measure point, for example, 120 error data, are equalized, respectively, and the error correction data of the motor revolving shaft 4 made one revolution are created.
[0037] The format of the created error correction data can be made into the amendment pulse number for error correction to each angle-of-rotation location in a part of the motor revolving shaft 4 made one revolution. For example, the number of amendment Hals measured every 3 degrees as mentioned above can be used as the correspondence table assigned to the rotation location in every 3 degrees of the motor revolving shaft 4.
[0038] Instead the fourier expansion into series of the error correction data of the motor revolving shaft 4 made one revolution is carried out, and it asks for an approximation curve, and may be made to carry out storage maintenance by using each multiplier of the Fourier series showing the approximation curve concerned as error correction data. In this case, what is necessary is to compute amendment data by applying the multiplier which is carrying out storage maintenance to an approximate expression, and just to create the data stream of an amendment pulse in the initialization processing after turning on the drive power source of the drive control unit 1.
[0039]
[Effect of the Invention] The locational error resulting from the angular transmission error of a wave-motion gear reducer is measured beforehand, and the error-correction data which can amend the locational error in each rotation location of a motor revolving shaft are created, and he calculates the error correction value of the rotation location which corresponds from error correction data absolutely based on a location of a motor revolving shaft, and he is trying to amend position feedback information in the locational error amendment approach of the actuator of this invention at the time of actual error correction, as explained above. Therefore, according to this invention, the positioning accuracy of the actuator equipped with the wave-motion gear reducer is improvable.

[Translation done.]

* NOTICES *

TECHNICAL FIELD

[Field of the Invention] This invention relates to the drive control unit of the actuator which performs positioning actuation by the locational error amendment approach and the amendment approach concerned of the actuator equipped with the wave-motion gear reducer.

[Translation done.]

PRIOR ART

[Description of the Prior Art] The thing of a configuration of slowing down motor output rotation with a wave-motion gear reducer, and moving the member by the side of a load to a target position as an actuator, is known. The wave-motion gear reducer is equipped with the annular rigid internal gear, the annular flexible external-tooth gearing, and the wave-motion generator.
[0003] With a typical configuration, a flexible external-tooth gearing is ****(ed) by the ellipse form by the wave-motion generator, the external-tooth part located in the both ends of the direction of an ellipse form major axis is clenched by the internal-tooth part to which a rigid internal gear corresponds, and this wave-motion generator is a motor. If rotated, both gearings' engagement position will move to a circumferencial direction, and the relative rotation according to both gearings' number-of-teeth difference (2n sheet, n= 1, 2, 3 ...) will occur on both the gearings concerned. Generally, the number of both gearings' number-of-teeth differences is two, and a rigid internal gear is fixed, a flexible external-tooth gearing rotates as a moderation rotation output element, and the rotation drive of the member by the side of the load connected with the flexible external-tooth gearing concerned is carried out at a low speed. The reduction gear ratio i in this case is $i= 1/R = (Zf-Zc)/Zf$. Here, R is a ** ratio, Zf is a flexible external-tooth gearing's number of teeth, and Zc is the number of teeth of a rigid internal gear. For example, in the case of $Zf=100$ and $Zc=102$, a reduction gear ratio i is 1/50, and output rotation becomes the reverse sense to a motor rotation direction.
[0004] Generally the drive control device of the actuator of this configuration is performing point-to-point control of an actuator by feedback control.

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EFFECT OF THE INVENTION

[Effect of the Invention] The locational error resulting from the angular transmission error of a wave-motion gear reducer is measured beforehand, and the error-correction data which can amend the locational error in each rotation location of a motor revolving shaft are created, and he calculates the error correction value of the rotation location which corresponds from error correction data absolutely based on a location of a motor revolving shaft, and he is trying to amend position feedback information in the locational error amendment approach of the actuator of this invention at the time of actual error correction, as explained above. Therefore, according to this invention, the positioning accuracy of the actuator equipped with the wave-motion gear reducer is improvable.

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL PROBLEM

[The technical problem which invention will solve and to carry out] However, there is an angular transmission error in a wave-motion gear reducer, and an error occurs according to this error between the actual positioning location by the actuator output shaft (output shaft of a wave-motion gear reducer), and a target positioning location. If this error can be compensated, the positioning accuracy of the actuator equipped with the wave-motion gear reducer can be improved.
[0006] if a locational error component when both gearings' number-of-teeth difference uses the wave-motion gear reducer of two sheets sets the ** ratio of the wave-motion gear reducer concerned to R here -- the error component (3) of the error component (2) period (R+1) of the (1) period R per output-shaft 1 rotation -- it can divide into the other error component. The error component of a period R originates in a rigid internal gear, and the error component of a period (R+1) originates in a flexible external-tooth gearing.
[0007] The technical problem of this invention is in the drive control device of the actuator equipped with the wave-motion gear reducer by adding the location amendment function for amending the above-mentioned locational error of the period (R+1) of (2) which originates in the feedback control loop of the position control at the angular transmission error of a wave-motion gear reducer to improve the positioning accuracy of the drive control device concerned.

[Translation done.]

MEANS

[Means for Solving the Problem] In the actuator equipped with the wave-motion gear reducer which the locational error amendment approach of this invention slows down :motor and motor output rotation, and is transmitted to a load side in order to solve the above-mentioned technical problem The locational error corresponding to a location of an actuator output shaft is measured absolutely. The error correction value which creates the error correction data to the rotation location of said motor revolving shaft, detects the rotation location of the; aforementioned motor revolving shaft, and is assigned to the detected rotation positional information in the; aforementioned error correction data is added to the rotation positional information concerned. It is characterized by using the rotation location amendment information of which created rotation location amendment information and; creation was done as position feedback information for carrying out point to point control of said output shaft.
[0009] What is necessary is here, for said output shaft to measure said locational error by at least 1-/(R+1) rotation, and just to create said error correction data.
[0010] What is necessary is generally, for said output shaft to measure said locational error a part made one revolution at least, and to average the measured error data and just to create the error correction data showing the error correction value over each rotation location of said motor revolving shaft.
[0011] Next, this invention By the above-mentioned approach A locational error the drive control device of the actuator to amend -- it is -- : -- the error correction data storage section said error correction data are remembered to be, and; -- the output-shaft zero sensor for [of said output shaft] detecting a location absolutely, and; -- the position transducer and; which detect the rotation location of said motor revolving shaft -- said -- an output-shaft zero sensor And the rotation positional information supplied from said position transducer and the rotation location amendment information creation section which creates said rotation location amendment information based on said error correction data; Said created rotation location amendment information is made into position feedback information. It is characterized by having the feedback control section which carries out feedback control of said actuator so that it may become the target position shown using location command information.
[0012] What is necessary is here, to be able to carry out storage maintenance of said error correction data at said position transducer, and just to download from this position transducer after powering on in this case at said error correction data storage section.
[0013] Moreover, said error correction data can be made into the data stream of an amendment pulse, or the multiplier train of the approximate expression showing the error correction information concerned.
[0014]
[Embodiment of the Invention] An example of the drive control unit of the actuator which applied this invention to below with reference to the drawing is explained.
[0015] Drawing 1 is the outline block diagram showing the drive control unit of the actuator of this example. this -- a drive -- a control device -- one -- driving -- having -- a book -- an example -- an actuator -- two -- a motor -- three -- this -- a motor -- a revolving shaft -- four -- connecting -- having had -- the wave motion -- a gear reducer -- (-- HD --) -- five -- a motor -- a revolving shaft -- four -- absolute rotation -- a location -- detection -- being possible -- a position transducer -- six -- the wave

motion -- a gear reducer -- five -- an output shaft -- namely, -- an actuator -- an output shaft -- seven -- absolutely -- a location -- detecting -- a sake -- a zero -- a sensor -- eight -- having -- **** . Position transducers 6 are position transducers which can detect a location absolutely, such as a rotary encoder and a potentiometer.

[0016] It has an internal gear, a rigid flexible external-tooth gearing, and a rigid wave-motion generator, and a wave-motion generator is used as a motor rotation input element, and an internal gear is fixed and let wave-motion gearing 5 be the output element (output shaft 7) of moderation rotation of a flexible external-tooth gearing. The wave-motion generator has an ellipse form, the number of both gearings' number-of-teeth differences is two, and a flexible external-tooth gearing is stir-fried by the ellipse form, and meshes partially at the both ends of the direction of a major axis of an ellipse form to a rigid internal gear, and two engagement positions move him to a circumferencial direction with rotation of a wave-motion generator. Since the reduction gear ratio i of wave-motion gearing 5 is i= 1/R = (Zf-Zc)/Zf, number-of-teeth Zf=100 of a flexible external-tooth gearing, and in the case of number-of-teeth Zc=102 of a rigid internal gear, a reduction gear ratio i is 1/50, and output rotation becomes the reverse sense to a motor rotation direction.

[0017] The drive control unit 1 which controls the drive of an actuator 2 The error correction data storage section 11 the error correction data 10 for compensating the locational error resulting from the angular transmission error of the wave-motion gear reducer 5 are remembered to be, The rotation positional information 12 supplied from a position transducer 6, and the rotation location amendment information creation section 14 which creates the rotation location amendment information 13 based on the error correction data 10, It has the feedback control section 16 which carries out feedback control of the actuator 2 by making created rotation location amendment information 13 into position feedback information so that it may become the target position shown using the location command information 15. The above-mentioned rotation location amendment information creation section 14 can be used as an adder or a subtractor.

[0018] (Error correction data) Here, the error correction data 10 of this example are created as follows. First, the locational error of the motor revolving shaft 4 in an actuator 2 is compressed into 1 for a reduction gear ratio of the reducer concerned by moderation of the wave-motion gear reducer 5 with which this is connected. Since the ** ratio of the wave-motion gear reducer 5 is 50 in this example, the locational error of the motor itself is compressed into 1/50. Therefore, since the locational error of an actuator 2 originates mainly in the angular transmission error of the wave-motion gear reducer 5, the unidirectional-approach precision of the actuator 2 concerned will be decided by the angular transmission error of the wave-motion gear reducer 5.

[0019] Unidirectional-approach precision positions one after another in the hand of cut of the fixed direction, and is each location, the difference of the include angle actually rotated from the criteria location and the include angle which should be rotated is searched for, and the maximum under 1 rotation of these values is expressed.

[0020] In this example, the locational error of the unidirectional-approach precision of an actuator 2, i.e., an actuator, is measured a part of the actuator output shaft 7 made one revolution based on the absolute location of an output shaft 7. Since it is reduction gear ratio i=1/50 of the wave-motion gear reducer 5 in this example, when the motor revolving shaft 4 rotates 50 times, an output shaft 7 (flexible external-tooth gearing) will make one revolution. In this measurement, the output of the zero sensor 8 is absolutely used at the time of the initial actuation for location detection.

[0021] In addition, instead of unidirectional-approach precision, even if the include-angle intermediary precision of a wave-motion gear reducer is used for the data to measure, they are substantially the same. Moreover, although a part for 1-/(R+1) rotation of an output shaft 7 is sufficient as measurement, it may continue more than one revolution and, of course, you may measure.

[0022] Next, the measured data are equalized and the error correction data 10 corresponding to the rotation location of the motor revolving shaft 4 are created. Below is enough for the magnitude of this error correction data 10 by one rotation of the motor revolving shaft 4.

[0023] The format of the created error correction data 10 can be made into the amendment pulse number

for error correction to each angle-of-rotation location of the motor revolving shaft 4. Instead the fourier expansion into series of the error correction data of each rotation location of the motor revolving shaft 4 is carried out, and it asks for an approximation curve, and may be made to carry out storage maintenance by using each multiplier of the Fourier series showing the approximation curve concerned as the error correction data 10. In this case, what is necessary is to compute amendment data by applying the multiplier which is carrying out storage maintenance to an approximate expression, and just to create the data stream of an amendment pulse in the initialization processing after turning on the drive power source of the drive control unit 1.

[0024] Here, in this example, since this error correction data 10 should just create the thing of the die length equivalent to 1/(R+1) of an output shaft 7, since it is the ** ratio R= 50, if it converts into an input shaft (motor revolving shaft), a motor revolving shaft needs to create the data for 360 degreex50 / 51= 352.9-degree rotation. This error correction data 10 is every 3-degree rotation of a motor revolving shaft and 352. It can set up every 120 9-degree division. However, it is 352 in this case. What is necessary is to establish an origin/datum in an output shaft 7 and just to create amendment data on the basis of there, since the include angle of 9 degrees cannot be accepted. It is a motor revolving shaft and is 359. ********** (R+1) and amendment for one rotation of an output shaft 7 will be made in 2-degree amendment.

[0025] (Locational error amendment actuation) Next, amendment of the locational error which is the description part of the drive control action of the actuator 2 by the drive control device 1 is explained. It asks for the amendment pulse number of the motor revolving shaft 4 expressed by the feedback pulse concerned which corresponds from the error correction data 10 absolutely based on a location, the amendment pulse number is added to a feedback pulse (12) in the rotation location amendment information creation section 14, and it returns to the feedback pulse (12) of the location detection from a position transducer 6 by making an addition result into a location feedback pulse (13) at the feedback-control section 16. In the feedback control section 16, based on the location feedback pulse (13) concerned, feedback control of the actuator 2 is carried out so that it may become the target position directed using the location command information 15 that it is inputted.

[0026] In addition, in this example, it is made to carry out storage maintenance of the error correction data 10 at the drive control unit 1. Instead, storage maintenance of the error correction data 10 may be carried out at the position transducer 6 of an actuator 2. In this case, what is necessary is just to constitute in initialization processing immediately after supplying a power source to the drive control device 1, so that the error correction data 10 currently held at the position transducer 6 of an actuator may be downloaded to the drive control-device 1 side.

[0027] (Gestalt of other operations) Although the above-mentioned example performs control which removes the error of the period (R+1) contained in an actuator, if the error component of a period R is also removed collectively, of course, it can perform locational error amendment with a very high precision.

[0028] First, the error component of a period R is removable as follows. That is, the locational error of such an output shaft can be amended based on the absolute location of one revolution of a motor revolving shaft. Specifically the locational error of an actuator 2 by [of one revolution of the motor revolving shaft 4] measuring based on a location absolutely As opposed to the rotation positional information which creates error correction data, detected the rotation location of the motor revolving shaft 4, and was detected What is necessary is to add the error correction value currently assigned to the rotation location concerned in error correction data, to create rotation location amendment information and just to use the created rotation location amendment information as position feedback information for carrying out point to point control of the output shaft.

[0029] In this case, when [of the motor revolving shaft's 4 one revolution of the locational error of an actuator 2] an output shaft measures by one revolution at least based on a location absolutely, error correction data can be created. Moreover, the error data of the motor revolving shaft's 4 one revolution of the locational error of an actuator 2 which the output shaft 7 measured a part made one revolution at least based on the location absolutely, and were measured can be averaged, and the error correction data

showing the error correction value over each rotation location for one motor revolving-shaft revolution can be created.
[0030] Next, in order to remove the error component of a period (R+1), and the error component of a period R, to prepare two kinds of amendment tables for amending these errors for the location amendment data storage section in <u>drawing 1</u> as location amendment data, and based on the absolute location of an input shaft 4, to draw correction value from two tables and what is necessary is made just to amend to coincidence.
[0031] Here, the error correction data of a period (R+1) can be created based on the data after error assistant Masashige part removal of a period R (data obtained by observation data or simulation). Of course, since the error component of a period (R+1) is also calculable from a measurement result, the error component of an output shaft 7 may be measured and the error correction table of a period (R+1) may be directly created from there.
[0032] In addition, amendment actuation of the creation approach of the error correction data of a period R and the error component of a period R using the error correction data concerned is explained below.
[0033] First, the locational error of the unidirectional-approach precision 2 of an actuator 2, i.e., an actuator, is measured a part of the actuator output shaft 7 made one revolution based on the absolute location of the motor revolving shaft 4. For example, when the ** ratio of the wave-motion gear reducer 5 is 1/50 and the motor revolving shaft 4 rotates 50 times, an output shaft 7 will make one revolution.
[0034] Based on the output of a position transducer 6, this locational error is measured, whenever 3 degrees of motor revolving shafts 5 rotate. In this case, a measure point is 120 points (360 degrees / 3 degrees) about the motor revolving shaft 5, and becomes a part for 120 point x (** ratio) in the actuator output shaft 7.
[0035] In addition, instead of unidirectional-approach precision, even if the include-angle intermediary precision of a wave-motion gear reducer is used for the data to measure, they are substantially the same. Moreover, as for measurement, it is needless to say that it may continue not only a part of an output shaft 7 made one revolution but more than one revolution, and you may measure.
[0036] Next, the error data of each measure point, for example, 120 error data, are equalized, respectively, and the error correction data of the motor revolving shaft 4 made one revolution are created.
[0037] The format of the created error correction data can be made into the amendment pulse number for error correction to each angle-of-rotation location in a part of the motor revolving shaft 4 made one revolution. For example, the number of amendment Hals measured every 3 degrees as mentioned above can be used as the correspondence table assigned to the rotation location in every 3 degrees of the motor revolving shaft 4.
[0038] Instead the fourier expansion into series of the error correction data of the motor revolving shaft 4 made one revolution is carried out, and it asks for an approximation curve, and may be made to carry out storage maintenance by using each multiplier of the Fourier series showing the approximation curve concerned as error correction data. In this case, what is necessary is to compute amendment data by applying the multiplier which is carrying out storage maintenance to an approximate expression, and just to create the data stream of an amendment pulse in the initialization processing after turning on the drive power source of the drive control unit 1.

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

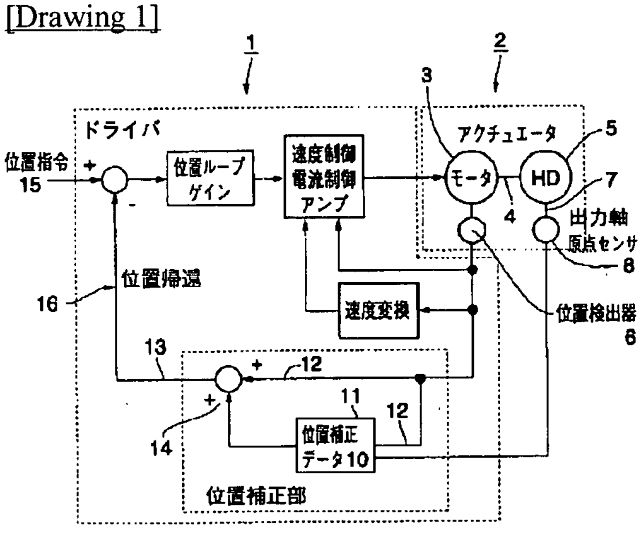
[Brief Description of the Drawings]
[Drawing 1] It is the outline block diagram showing an example of the drive control device of the actuator which applied this invention.
[Description of Notations]
1 Drive Control Unit
2 Actuator
3 Motor
4 Motor Revolving Shaft
5 Wave-Motion Gear Reducer
6 Position Transducer
7 Output Shaft of Wave-Motion Gear Reducer (Actuator Output Shaft)
8 Zero Sensor
10 Error Correction Data
11 Error Correction Data Storage Section
12 Rotation Positional Information
13 Position Feedback Information
14 Rotation Location Amendment Data Origination Section
15 Location Command Information
16 Feedback Control Section

[Translation done.]

* NOTICES *

DRAWINGS

[Drawing 1]



システム構成

[Translation done.]